A comparative study of phase angle predictive equations using bituminous binder data

Abstract

This study investigates the validity of several phase angle (d) predictive equations; the Kramers- Kronig relationship, Christensen and Anderson (CA), Christensen Anderson andMarasteanu (CAM), Al-Qadi and co-workers, fractional and arctan (G"/G') models on unmodified and polymer modified bitumens (PMBs), unaged and aged samples. The viscoelastic properties of these binders were determined by means of a dynamic shear rheometer covering a wide range of temperatures and frequencies. The results indicate that most of the models are able to predict the viscoelastic behaviours of unmodified bitumens reasonably well. However, some equations failed to predict the appearance of a plateau in the d master curves of PMBs. The goodness-of-fit statistics between measured and predicted d shows that the fractional model yielded the most outstanding correlation for all test samples, followed by the Al-Qadi and co-workers, CAM, CA, arctan (G"/G') and Kramers- Kronig relationships. As expected, an anomaly is observed between measured and predicted d of the Kramers-Kronig relationship particularly at high frequencies. The fractionalmodel is, however, not considered suitable for practical purposes due to the high number of coefficients that need to be solved even though this model is able to satisfactorily predict the viscoelastic properties of the unmodified bitumens and PMBs.